the formation of the embryos; at the very outset a mass of cells is seen to isolate itself at the periphery, in the shape of a crescent, which gradually increases in size and becomes separated off to form, in all probability, the granular mass which fills the amniotic tube and encompasses the embryos.

The result of the foregoing observation is therefore the discovery of a mode of reproduction which is entirely new among the Arthropoda, and of which it is difficult, I think, to find an equivalent among the Metazoa. Now, how are we to interpret this curious case of metagenesis? Must we consider the tube containing the chain of embryos as a nurse, of which the soma would be represented by the epithelial tube and by the internal cells which do not participate in the formation of the embryos? We cannot help thinking of the Cysticerci and the Orthonectida; but comparisons of this sort would at present be injudicious. We prefer to confine ourselves to the facts, waiting for their general interpretation until the observations which we are pursuing upon different species furnish us with more ample data.

VI.—*Seasonal Dimorphism in Butterflies of the Genus* Precis, *Doubl.* By Guy A. K. Marshall, F.Z.S.

It is now nearly two years since I recorded my conviction (Trans. Ent. Soc. 1896, p. 557) that seasonal dimorphism of a singularly marked character existed among certain African species of the genus *Precis*. This opinion, based as it was on field observations alone and not on actual breeding experiments, did not appear to receive general acceptance; and this is perhaps hardly to be wondered at seeing how very marked are the differences between such forms as *octavia* and *sesamus*, *simia* and *cuama*, *archesia* and *pelasgis*, &c.

The only counter evidence of any importance, however, which has come under my notice is that adduced by that eminent entomologist Mr. W. L. Distant in his interesting notes on Transvaal butterflies (Ann. & Mag. N. H. (7) vol. i. p. 51). He there says, "I found *Precis octavia* var. exceedingly scarce in the Transvaal, having only secured one specimen at Pretoria. I have since received another example from Johannesburg. *P. sesamus*, on the contrary, was very abundant, and always during the wet or summer season, frequenting my small flower-garden. Hence I have found no evidence for the proposition made by Mr. Guy A. K. Marshall that the two species are identical, or, rather, that *P. octavia* is the wet-season and

P. sesamus the dry-season form." This statement, coming as it does from the pen of such an authority as Mr. Distant, would at first sight appear to entirely refute my contentions. But seasonal dimorphism is a curiously complex phenomenon, and personally I venture to think that his experience is an exceptional, and at the same time an extremely interesting, one; for, apart from my own observations, it is quite at variance with those of several thoroughly observant S.-African collectors with whom I have discussed the subject and whose acquaintance with the species is even more extensive than that of Mr. Distant. Among these the testimony of Mr. C. N. Barker is of particular importance, for he has observed *P. octavia* (*s. l.*) for many years from a dimorphic standpoint, not only in Natal, but also in Zululand, Swaziland, and Tongaland, and he has been firmly convinced that *P. sesamus*, Trim., there represents its dry-season phase, having arrived at that conclusion prior to myself and quite independently.

It therefore gives me no little pleasure to be able to indicate the accuracy of the observations of my genial friend, to whom is due the credit of having first drawn attention to the widespread occurrence of seasonal dimorphism among African butterflies. For after not a few disappointments I have at last succeeded in breeding typical *P. sesamus*, Trim., from eggs laid by three separate females of *P. octavia*, subsp. *natalensis*, Staud.—thereby establishing beyond doubt what is certainly the most remarkable instance of seasonal variation as yet known among the Lepidoptera.

As a consequence of this, the synonymy of the species will now stands as follows:—

Wet-season form.	Dry-season form.
P. octavia, Cram.	=[*P. amestris*, Drury.]
[*P. octavia*, var. *natalensis*, Staud., = *calescens*, Butl.]	= *P. octavia*, subsp. *sesamus*, Trim.

The following notes on the early stages of the species may perhaps be of interest. On the 13th February of this year I took five eggs laid by a female *o.-natalensis*; of these two proved infertile and the remaining three hatched on the 19th. One larva died when quite small, but the others thrived and finally pupated, one early on the 20th, the other on the 21st. The former emerged on the 4th April as *sesamus*, the latter was unfortunately damaged by mischance and failed to emerge. On the 27th February I obtained three eggs from another female of the same form. Two of these hatched on the 5th March; the third hatched next day, but the larva died. The surviving larvæ developed somewhat unevenly,

one pupating on the 31st March, the other not till the 5th April. The former produced *sesamus* on the 15th April, and the latter emerged on the 20th, producing, curiously enough, pure *o.-natalensis*. From a third female I secured one egg on the 6th March ; this hatched on the 12th ; the resulting larva pupated on the 7th April and emerged on the 30th as full *sesamus*.

The females of this species, like many other *Nymphalinæ*, are somewhat dilatory in their method of ovipositing and often take a long time making up their minds where to deposit an egg ; indeed they seem unable to lay them in anything like quick succession, in which they differ notably from most *Pierinas*. I have seen *Belenois mesentina* lay 80 eggs straight off, with scarcely a pause and on a single leaf. The food-plant of *sesamus* in Salisbury is a low straggling plant, of almost creeping habit, which grows in somewhat matted clumps on the slopes of wooded kopjes. The egg is placed anywhere on the stem or leaves, and in one instance I saw one deposited on a piece of grass adjoining the food-plant. Compared with the size of the insect the egg seems small, the vertical axis is longer than the horizontal, the shape being that of an obtuse cone ; from a circular shallow depression on the vertex radiate 13 (sometimes 12) vertical lamelliform ridges, which under a pocket-lens appear to be delicately fluted transversely ; the whole egg is glabrous and of a pale glaucous green colour. As will be seen from the dates given above, the oval stage in autumn lasts about six days. The larva on exclusion is dull sepia-brown in colour, being paler towards extremities and set with long black hairs ; the head is black. The hairs develop into spines after the second moult. The description of the full-grown larva is as follows :—Length about 35 mm. ; ground-colour dull velvety black (varying sometimes to very dark crimson) ; a narrow central black line, on each side of which are four short transverse yellow lines on each segment ; these become almost obsolete anally, whereas on third segment they coalesce, forming a large dorsal yellow patch divided in its posterior half by the dark central line ; second segment entirely yellow, with a short transverse central black bar ; a broad macular yellow lateral stripe much dilated on thoracic segments. Each segment bears a transverse row of six long, stout, branched spines, which are black with a distinct dark blue metallic reflection, and two smaller ones placed longitudinally just above legs. Head with a deep central impression on vertex (almost bifid), testaceous yellow with a large lateral spot and a broad frontal V-shaped mark black, mouth

blackish; from the vertex spring two spines similar to those on the body but half as long again, stouter and somewhat clubbed instead of sharply pointed. Legs and prolegs shining black, the latter with apical third part light yellow. The dorsal yellow markings are variable in development and occasionally absent. The pupa also presents two forms of coloration: one, the gilded form, usually characteristic of the dry season, has already been described by Mr. Trimen (S. Afr. Butt. vol. iii. App. p. 401) with his wonted clearness and thoroughness of detail; the other differs only in being entirely dull brownish black, with two subquadrate shiny black patches on wing-covers.

The colouring of the larva, judging by the few examples I have examined, is not affected by season, and the greater or less development of the yellow markings does not seem to bear any intimate relation to the two forms of imago. The sharp and thickly-set branched spines are doubtless an efficient defence against certain enemies and perhaps account for the general lack of procryptic colouring in the larvæ of this and allied genera. But despite their somewhat noticeable appearance and the comparative commonness of the perfect insect, my diligent search for larvæ has met with a singular want of success. Up to the present I know of only two enemies that attack the larva: one is a small ichneumon which kills it before it is one-third grown; the other is a Hemipteron of the family Lygæidæ, which has a predilection for caterpillars of all kinds, even to hairy monsters 6 inches long. Both forms of pupa are certainly procryptic in colouring. During the moist summer months the withered leaves of the food-plant turn dark brown or black, instead of yellow as in the winter, so that in both cases the pupa is well adapted to its surroundings, looking like a bit of shrivelled leaf. In one instance I have bred the wet-season form from a golden pupa, but I have not yet reared typical *sesamus* from the dark form.

The differences between the seasonal forms of the imago are not confined to shape and colour alone, but there is likewise a very appreciable divergence in habits, which has been referred to by Mr. Trimen. Speaking broadly, the *natalensis* form frequents the highest points in any neighbourhood, especially if they be more or less open (for it is anything but a sylvan insect); whereas the *sesamus* form is more partial to shady spots, and is to be found in ravines and sprints or rocky wooded slopes, and shares with the Hesperid *Sarangesa motozioides*, Holl., a marked affection for disused mining-shafts and cuttings. This distinction must not be

taken too strictly, for true *sesamus* is occasionally found in company with its summer form in open hill-tops, but principally at the change of seasons; but *natalensis*, so far as my experience goes, is never to be found in the more shady stations frequented by *sesamus*. The latter, moreover, is distinctly warier and more difficult of approach when not feeding, and if alarmed flies off with a rapid, and often zigzag, flight, settling abruptly among rocks or herbage, when its greenish-black underside colouring is equally protective. *Sesamus* is more often observed in gardens, and not unfrequently enters human habitations in search of a shady resting-place. This difference in the stations frequented by the two forms may possibly go some way to account for Mr. Distant's experience in Pretoria—at least so far as the rarity of the wet-season form is concerned. The town is situated in a hollow "almost surrounded by high and barren hills," and it does not seem to me improbable that the *natalensis* form might only be found on the summits of the range. A somewhat parallel instance was pointed out to me by Mr. J. M. Hutchinson in the case of his own farm in Natal, which lies in an open plain between two ranges of hills. He has found *sesamus* resident on the farm, occurring fairly commonly along the banks of the sprints during the winter, whereas *natalensis* is very much scarcer and non-resident, the examples seen having always been travelling from one range of hills to the other, on both of which it is common. This I had a good opportunity of observing for myself when enjoying Mr. Hutchinson's hospitality in 1896.

The curious congregating habits of typical *sesamus* (which likewise constitute a marked distinction from its summer form) have already been recorded, but I have only had two opportunities of observing them in anything like numbers: once in April 1893, when I disturbed about 30 specimens from under the bank of the Sundays River in the north of Natal. The second occasion was at Hartley Hills in Western Mashonaland, when I found a large concourse of these insects going to roost under a projecting granite rock; I managed to number them up to eighty as they flew out, but then lost count, there being certainly over a hundred. I have observed this habit of roosting in company in species of *Euralia*, also in *Belenois*, *Herpœnia eriphia*, and *Teracolus eris*, but the reason for it is not altogether evident to me.

The divergences in habits between *natalensis* and *sesamus* are, however, insignificant as compared with their radical differences in colouring. The brilliant salmon-red upperside of the wet form with its black borders and spots stands in

marked contrast to the equally striking blue, red-spotted *sesamus*; nor is this less remarkable beneath, for the underside of the former is almost as brightly coloured as its upperside, whereas in the dry form the sombre greenish black is evidently of a procryptic nature. It is clear that some potent cause must have been at work to produce such an effect. My kind friend Prof. E. B. Poulton, in one of his interesting and instructive letters, has suggested that the colouring of all brilliant butterflies, whose undersides are not of a procryptic character, may indicate that they possess a certain amount of distastefulness—in other words, that they exhibit in a more or less incipient stage the phenomenon of warning or aposematic coloration. Although it may appear presumptuous for me to differ from such an eminent authority on these matters, yet I must admit that the habits and general behaviour of *octavia-natalensis* in its native haunts raise very strong doubts in my mind as to its inedibility even in a slight degree. Yet had I known this insect from cabinet specimens alone, I should certainly have been strongly inclined to include it in the category of aposematic butterflies, in consideration of its colouring, which is very noticeably brighter and more conspicuous on both surfaces than in several of the S.-African species known to possess distasteful qualities. It is true that I have never seen the insect attacked by birds (though this would apply to the vast majority of S.-African butterflies), but I have not unfrequently seen both forms captured by rock-frequenting lizards, particularly a dull brownish species with a bright blue tail—an admirable example, by the way, of colouring to attract attention to a non-vital part. I have also seen these reptiles capture *Precis archesia*, Cram., *Pseudonympha vigilans*, Trim., and *Durbania amakosa*, Trim., and doubtless many other rock-loving butterflies fall a prey to them. Another significant fact, pointing to an absence of inedible qualities, is the eminently procryptic underside colouring of the dry form, which is quite at variance with what we should naturally expect in a distasteful species. Moreover the activity and constant alertness of the insect is in marked contrast to the slow, laboured, or gently sailing, flight of its protected relatives; and indeed I opine that it would prove more than a match for the average insectivorous bird.

As we have already seen, *o.-natalensis* is particularly fond of bare elevated ridges and hill-tops, in which stations insectivorous birds and mammals are generally scarce or even absent. Here its chief enemies would only be the rock-lizards and such invertebrates as Asilidæ and Mantidæ. Now it is a generally recognized fact that animals, and more

particularly insects and birds, tend to develop brilliant colours whenever they are able to do so with impunity, and it is therefore quite conceivable that a strong-flying and wary insect like this should be able to indulge this tendency without unduly endangering its chances in the struggle for existence. This is more especially probable during the wet or summer season, when the lizards would be able to find a considerable amount of other food in the shape of small Coleoptera, Diptera, &c., and would therefore be less inclined to attempt the more difficult feat of stalking butterflies. But as the cold dry season advances the vast majority of these small fry disappear, either dying off or retiring to winter-quarters, and, as a consequence, those butterflies which remain on the wing during that time—and the majority of species in this country do so—would suffer far more persecution at the hands of their various foes, and would thereby be compelled to adopt protective measures in the way of procryptic colouring and greater wariness. This, in the case of *o.-natalensis*, would have resulted in the dry form *sesamus*; although why the salmon-red upperside should be changed to blue is not altogether evident, except perhaps that the latter colour is more in keeping with the shady haunts so often frequented by that form. It is instructive to note that the typical form of *octavia*, which occurs in the forest-clad regions of West Africa, has not been able to develop the brilliant hues of its eastern subspecies, being smaller and much more dully coloured; this being probably due to the keener struggle for existence in that country. At the same time its representative dry form *amestris*, Drury, shows a slightly less divergence from it than does *sesamus* from *natalensis*, which might perhaps be attributed to the less marked contrast in the general conditions of the environment at the two seasons.

It has been pointed out by Mr. L. de Nicéville, and also by Prof. Weismann, that both forms of any dimorphic species must be adaptive, otherwise the non-adaptive form would be gradually supplanted by its more favoured relative. While fully accepting the general principle of this argument, it does not seem to me necessary that we should have to assign some specially adaptive character to each form, exclusive of that general adaptation to the surrounding conditions of life without which no species could exist. For there is nothing to show that the development of a dry-season phase is not a geologically recent event, and the process of elimination of the non-adaptive wet form may be going on slowly but surely under our very eyes. Mr. Distant's observations of

sesamus at Pretoria might be adduced as corroborative evidence, and similarly the typical *octavia* would appear to be scarcer on the West Coast than its dry form ; further, the typical dry form of *P. archesia* has been occasionally observed at the height of the wet season, and in the case of *P. artaxia*, Hew., the experiences of both Mr. F. C. Selous and myself appear to show that in the low-lying coast districts of Portuguese Manika the leaf-like typical form alone occurs all the year round, whereas on the plateaux of the interior the summer form is represented by *P. Nachtigalii*, Dew., the typical form occurring only in the winter, and being generally more plentiful. That this view of the subject is a necessarily correct one I would not venture to assert, but in the light of the foregoing facts it is at least probable.

On the other hand it is not impossible that the *natalensis* form may present an instance of mimetic coloration in its incipient stage ; at all events it possesses some very marked potentialities for development in that direction should the stress of circumstances ever call them into play. The scheme of colouring, as a whole, very notably recalls that of an *Acræa* in certain respects, this being especially the case on the underside of the hind wings, where the basal black patch enclosing some subquadrate whitish spots, the pink discal field traversed by a transverse row of black spots, and, finally, the black hind marginal border with its row of lunules are all characters which find a close parallel in the widespread *Acræa acara*, Hew., and its various local representatives. The upperside also presents several features suggestive of *Acræa*, and it is worth noting that the red ground-colour is clearly due to a great enlargement of the common submarginal band so characteristic of the genus *Precis* ; moreover, the falcation of the primaries and the anal angular projection of the secondaries is less developed in this species than in any other of the genus. I do not suppose the foregoing suggestion will find much favour with those entomologists, unfortunately not a few, who are still inclined to throw doubt on the grand theory of Batesian mimicry—a theory the truth of which is continually being brought home to the observant collector in the tropics, and with ever-increasing force.

In considering the problem of seasonal dimorphism it at once becomes evident that the directly exciting cause is a climatic one. The splendid series of experiments made by European observers, such as Prof. Weismann, Dr. Standfuss, and Mr. Merrifield, appear to leave no doubt that in that region the dimorphic tendency is brought into action by heat and cold, and that humidity plays practically no part therein.

So far as South Africa is concerned, I am strongly of opinion that the exact converse is the case, and on writing to Mr. de Nicéville he tells me that he is of entirely the same opinion as regards Indian butterflies, and cites Mr. Doherty's experiment in which, by the application of humidity, he produced the wet-season form of *Melanitis leda*, L., during the dry season. Unfortunately the few simple experiments which I have been able to make as yet are not of a sufficiently conclusive character to adduce here; but so far as they show anything they tend to support the humidity theory, and they also negative the supposition that heat—at least *dry* heat—tends to produce the summer form in this country. This state of affairs is not so contradictory as it might seem at first sight; for, in seeking for the climatic cause of dimorphism, we should naturally look to the more unstable factor in the climate of any given country. So far as temperature is concerned, the annual range in Europe is considerable, owing to the large land area; whereas S. Africa has a high diurnal and low annual range. Taking Prof. Ferrel's calculations, we find that the difference between the average temperatures for January and July on 40° N. lat. is 33°, and on 50° N. lat. it is 45°; whereas the greatest difference in the Southern Hemisphere is 15° between 20° and 30° S. lat., and diminishes to the north and south of these parallels. The annual range of humidity exhibits an exact converse to this, being comparatively small in Western Europe; whereas in S.E. Africa, as is well known, the contrast is most marked in this respect. There is therefore strong *primâ facie* evidence that humidity and not temperature is the exciting agent of dimorphism in this part of the world.

In the cases of what he terms "adaptive seasonal dimorphism," of which *P. sesamus* is an evident example, Prof. Weismann has come to the conclusion that an "alternation of the two forms is provided by nature, apart from the influences of temperature"; also "that temperature in general does not here take part as the actual cause, but that it is a question of a process of selection which goes on independently of the temperature, and gradually alters some of the ids." This does not appear to be an altogether satisfactory conclusion to my mind, for if the alternation in these cases were due entirely to selection apart from climatic causes, it seems evident that artificial temperatures could not in any way influence the appearance of either form. But Prof. Weismann has himself abundantly proved that artificial temperatures have a very potent influence in the case of *Vanessa prorsa*-

levana, and all his experiments clearly show that the climatic is the primary, and the selective the secondary cause; that is to say, the tendency to variation in certain directions was initiated by climatic agencies, and subsequently utilized and developed to a more or less high degree by natural selection for protective purposes. In cases of adaptive seasonal dimorphism selection can have only come into play in order to enable a given species to adapt itself to the varying conditions at two different seasons; but if these climatic changes were eliminated, it seems evident that natural selection alone would be incapable of producing seasonal dimorphism as we now see it. It is true that in certain cases Prof. Weismann found that certain pupæ out of a number experimented on produced the form that would have appeared in nature in spite of artificial temperatures, and it is on these exceptions that he founded the above propositions. But the more we investigate the matter the more clear it becomes that the actual cause which induces the change in a well-marked case of dimorphism is of a highly complex character: the vastly preponderating cause is either temperature or humidity, or both, as the case may be; but there is something beyond this of which we as yet know nothing. This is evidenced by such cases as that I have already quoted, where two larvæ reared from the egg under precisely similar conditions produced the full wet and full dry forms respectively; and not a few similar instances have come under my notice. I am not therefore inclined to attach very great importance to the exceptions found by Prof. Weismann in his temperature-experiments, for I doubt the possibility of artificially producing *all* the factors necessary to induce the transition from one seasonal form to another in every case; and, moreover, I am of opinion that the personal equation, if one may apply such a term to insects, must be taken into account.

We can, as a general rule, obtain a very fair idea as to how far natural selection has taken part in the production of any given case of seasonal dimorphism by taking into consideration the amount of difference between the two extreme forms and the rapidity of transition from one to another, for the more highly differentiated they are and the more abrupt the transition the greater has been the influence of selection. Indeed one could almost trace a scale of development from a species like *Acræa anemosa*, Hew., where the slight change in the black markings is probably due entirely to climatic causes; through the *Teracoli*, whose seasonal differences are part climatic, part selective; and culminating in *Precis sesamus*,

in which selection has been by far the more potent factor, so much so that the intermediate grades between the two forms have been so far eliminated as to be on the verge of extinction.

Salisbury, Mashonaland,
May 1898.

Postscript.—I have previously (Proc. Zool. Soc. 1897, p. 6) suggested that the application of a distinctive scientific name to each seasonal form of a dimorphic species is hardly more reasonable than in the case of sexual forms, and that the difficulty might be met by the general adoption of a set of signs, similar to those used for the sexes, to represent the extreme and intermediate stages. As I am not aware that any such signs have yet been proposed, I make bold to suggest the following, which I have found very useful in my own notes :—

Wet-season or summer ♂ = ⊗♂
Dry-season or winter ♂ = ⊙♂
Intermediate ♂ = ⊖♂

and similarly for the ♀. Should it be desired to mention only the form without reference to sex the circle and internal sign alone might be used, *e.g.* dry-season form = ⊙. The system doubtless has its drawbacks, but these, I venture to think, would be outbalanced by the advantage gained in preventing the continual repetition of such cumbersome phrases as wet-season form and summer form, neither of which cover the facts of the case, and further in checking the undue multiplication of varietal names.

VII.—*Descriptions of new Longicorn Coleoptera from East Africa.* By C. J. Gahan, M.A., of the British Museum (Natural History).

The new species of Longicorn beetles described in the following paper are, with a few exceptions, from the collections made by Dr. J. W. Gregory during his expedition to Mount Kenya and by Mr. C. S. Betton in the tract of country traversed by the railway running inland from Mombasa.

Xystrocera Ansorgei, sp. n.

Capite, prothorace et corpore inferiore brunneo-testaceis; elytris osseis, fusco punctatis et maculatis; pedibus brunneo-testaceis